

# **General Public Exposure due to Electromagnetic Fields of New Wireless Technologies in Different Environments**

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## **INTRODUCTION**

The WHO International EMF Project RF Research Agenda identified as a research topic a need for measurement surveys to characterize population exposures from all radio-frequency (RF) sources, with a particular emphasis on new wireless technologies [1]. There is a need to conduct measurements to assess the typical range of exposures from new wireless network technologies such as Femtocells, WiMAX, HSPA and LTE in a range of common locations (outside public areas, within buildings, homes, etc.). In this paper a methodology and design of measurement campaign will be presented to experimentally determine in-situ electromagnetic field exposure of general public due to new wireless sources in various environments.

## **MATERIALS AND METHODS**

RF exposure is assessed at sites, which are subdivided into different categories depending on the type of environment, population density, the available wireless technologies, and the expected amount and time of traffic. We choose the following six categories: residential area (including areas with schools, day-care centers, etc.), rural environment, urban environment, office environment, suburban environment and industrial environment. Two types of measurements will be executed, short-term and long-term measurements in Belgium, the Netherlands, and Sweden.

By executing short-term measurements we will assess the electric-field levels at different locations at each measurement site. The duration of one short-term measurement is about 30 minutes depending on the number of frequency bands to be measured. Typically short-term measurements (in- and outdoor) at 10 locations are executed per site. During the short-term measurements and during movement from one measurement position to another position, the operator will wear a personal exposure meter (PEM) to assess the electric field levels in twelve fixed frequency bands in the frequency range of 80 MHz up to 2.5 GHz. The measurement cycle of the different frequency bands will be repeated every 5 seconds.

The goal of the long-term measurements is to characterize the temporal behaviour of the different signals. Physical changes in the environment and varying amount of traffic cause variations in time of the electric field's amplitude. With a spectrum analyzer and tri-axial antennas, small-band measurements of GSM, UMTS- HSPA, LTE, and WiMAX are executed during at least 4 successive days (2 weekdays and 2 weekend days) on a fixed location. These long-term measurements are executed to obtain (temporal) variations of the electric field levels as function of the time of day (e.g., day, night), as function of the type of day (e.g., weekday, weekend day) and as function of the technology. The three orthogonal components of each present signal are measured consecutively (with RMS detector). Each sequence of measurements of GSM, UMTS-HSPA, ... signals lasts 1 to 3 minutes dependent on the number of present signals. This sequence is repeated continuously during at least 4 days.

In total 36 sites (6 sites per category) will be investigated and at each site short-term measurements at 10 locations will be performed, resulting in a total of 360 measurement

locations. Moreover we will perform long-term measurements at 2 sites per category (resulting in 12 long-term measurements). At each site we will measure the frequency spectrum in the frequency range of 80 MHz up to 6 GHz. Current wireless sources are mainly operating in this frequency range. Based on this spectrum overview only the most dominant signals will be measured more in detail. The main focus of this study lies on the exposure due to signals from GSM, UMTS, HSPA, LTE, and WiMAX. If present FM, DAB, DVB, etc. signals will also be measured.

## RESULTS

The statistical analysis of exposure at the 360 locations for 6 different environments will be explained at the BEMS conference. For a residential site, Figure 1 shows a long-term measurement. Momentary electric-field samples  $E_{mom}$  for the FM, GSM and UMTS-HSPA signal measured during the four days are displayed in Figure 1. The horizontal axis of Figure 1 shows the measurement time: the black solid vertical lines represent midnight and the black dashed solid vertical lines represent noon. The variation of the GSM signal is here much higher than these of the FM and UMTS signal due to mobile phone traffic. The variations are caused by physical changes in the environment and a varying amount of traffic (for GSM and UMTS). The FM signal delivers here the highest electric-field values. The UMTS signal remains very stable between 0 am and 12 am, only in the afternoon there is some traffic.

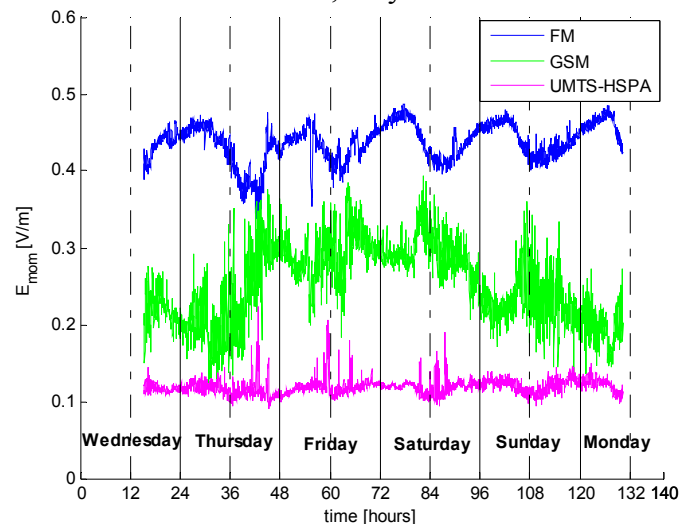


Figure 1: Variation of  $E_{mom}$  for the FM, GSM and UMTS signal for a duration of about 4 days.

## CONCLUSIONS

A measurement campaign to assess in-situ electromagnetic field exposure of general public due to new wireless sources in six different environments is presented. Short-term measurements at 360 locations (indoor and outdoor) are executed and long-term measurements at 12 locations are executed. The long-term measurements enable to characterize the temporal behavior of the different signals.

## ACKNOWLEDGMENTS

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## REFERENCES

- [1] <http://www.who.int/peh-emf/research/agenda/en/index.html>